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Improving decadal climate predictions by ocean ensemble dispersion filtering (EDF) and an efficient systematic evaluation framework (Freva)

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Abstract

Decadal climate predictions have the objective to predict the development of the climate for the following years to decades. Numerical Earth system models are initialized with observational values, similar to the methodology applied in weather forecasting. Additionally, they are forced by boundary conditions, like greenhouse gas scenarios, to project the long term development. This talk investigates decadal climate predictions with Earth system models and their further improvement with new strategies in research and technologies.

A modern decadal prediction system is evaluated and investigated for sources of potential skill. Hence a systematic evaluation strategy is developed. It contains the assessment of accuracy of the ensemble mean and the ensemble spread, and compares decadal experiments with climatology, observations, and climate projections. The entire assessment is performed within a novel evaluation system called Free Evaluation System Framework (Freva). This system is designed to complement climate modeling by a systematic and efficient assessment. Freva serves as a resource-efficient process framework between the data generation and its evaluation, to detect climate research potential. Freva runs on high performance computers to handle customizable evaluation systems of research projects, institutes or universities - to connect scientists. It combines different software technologies into one common hybrid infrastructure, including all features present in the shell and web environment.



A new prediction technique called 'Ensemble Dispersion Filter' is developed. It exploits two important climate prediction paradigms: the ocean's heat capacity and the advantage of the ensemble mean. The Ensemble Dispersion Filter averages the ocean temperatures of the ensemble members every three months, uses this ensemble mean as a restart condition for each member, and further executes the prediction. The evaluation by the new verification framework Freva shows that the Ensemble Dispersion Filter results in a significant improvement in the predictive skill compared to the unfiltered reference system. Even in comparison with prediction systems of a larger ensemble size and higher resolution, the Ensemble Dispersion Filter system performs better. In particular, the prediction of the global average temperature of the forecast years 2 to 5 shows a significant skill improvement.

Short bio



Christopher Kadow is an expert in climate modeling, prediction, and verification. His research and scientific achievements are primarily centred around decadal climate predictions and IT interfaces in climate science. He is the project coordinator and leading scientist of the project 'INTEGRated data and evaluation system for decadal scale prediction' within the major project on decadal climate prediction 'Mittelfristige Klimaprognosen'

(1) at the Freie Universität Berlin in Germany. His project INTEGRATION is responsible for the development of the central evaluation system in MiKlip (2). This central evaluation system is based on the Free Evaluation System Framework (Freva) and it includes data and software interfaces for a common developer base on high performance computers in web and shell. Since 2017 Christoph is leading the forecast group for the official German decadal forecast. Therefore his team developed a state-of-art forecast website as modern climate service for climate predictions (3). Furthermore he developed a novel forecast technique for decadal prediction (4). This technique – namely the ensemble dispersion filter – exploits the benefits of an ensemble forecast in combination with the ocean decadal memory to improve the multi-annual prediction skill. Besides decadal prediction he is involved in many climate modeling activities like for example the German contribution to CMIP6 (5) and climate modeling and verification teaching at the Freie Universität Berlin (6) - where Freva is also applied.

1 fona-miklip.de, 2 www-miklip.dkrz.de, 3 fona-miklip.de, 4 Kadow et al. 2017, 5 cmip-eval.dkrz.de, 6 freva.met.fu-berlin.de